A molecular line survey of a warm core and the medium around it in G0.253+0.016

"molecules *again* again?"

?

"no problem.........."

Alyssa Bulatek (she/her)
Committee: Adam Ginsburg, Desika Narayanan, Jaehan Bae, and Siyao Xu (UF Physics)
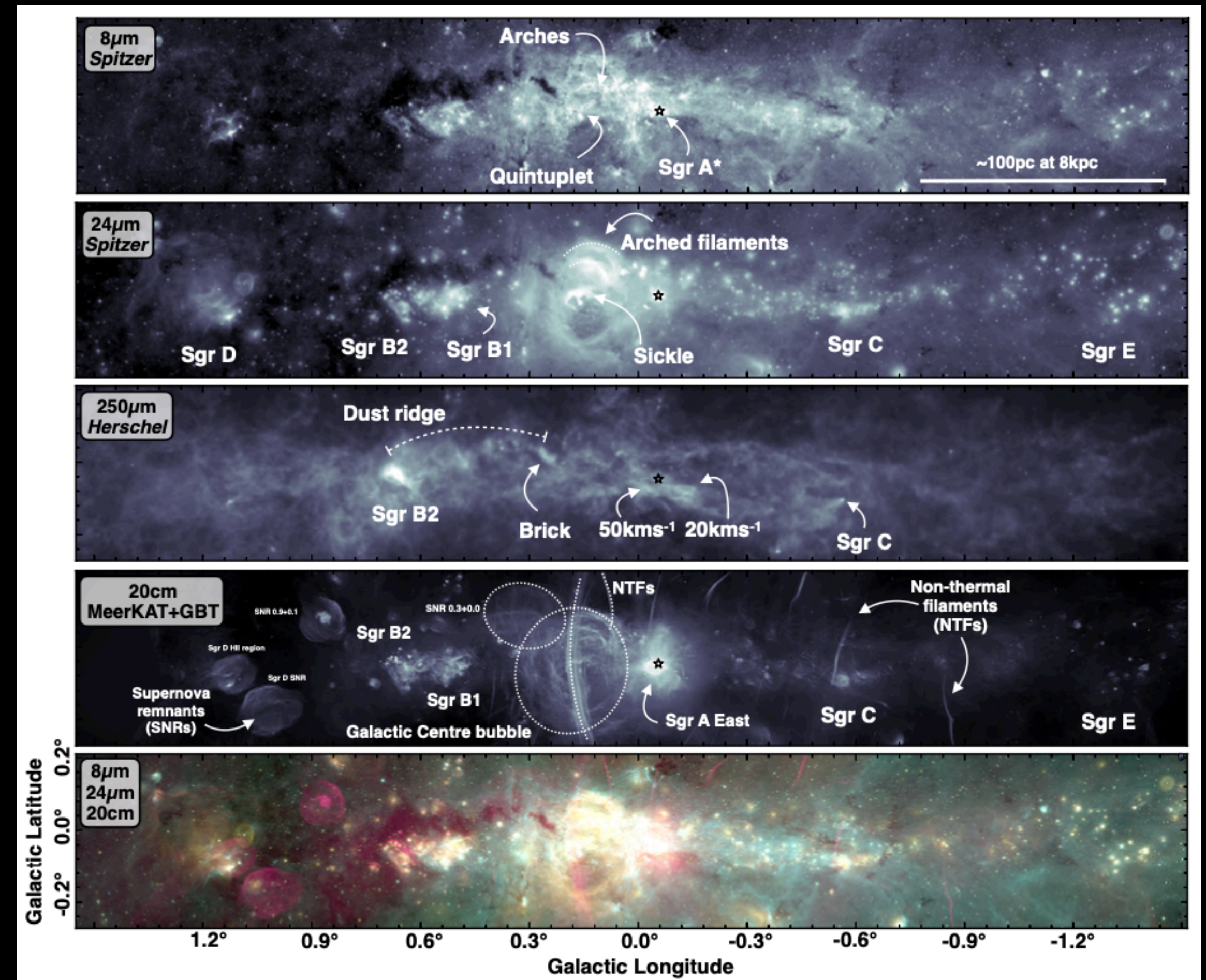
October 9, 2025
Graduate Symposium

The MW Galactic Center is unique (woah really?)

CMZ = Central Molecular Zone/molecular material within $R_{gal} \approx X00$ pc... plots from Henshaw+2023

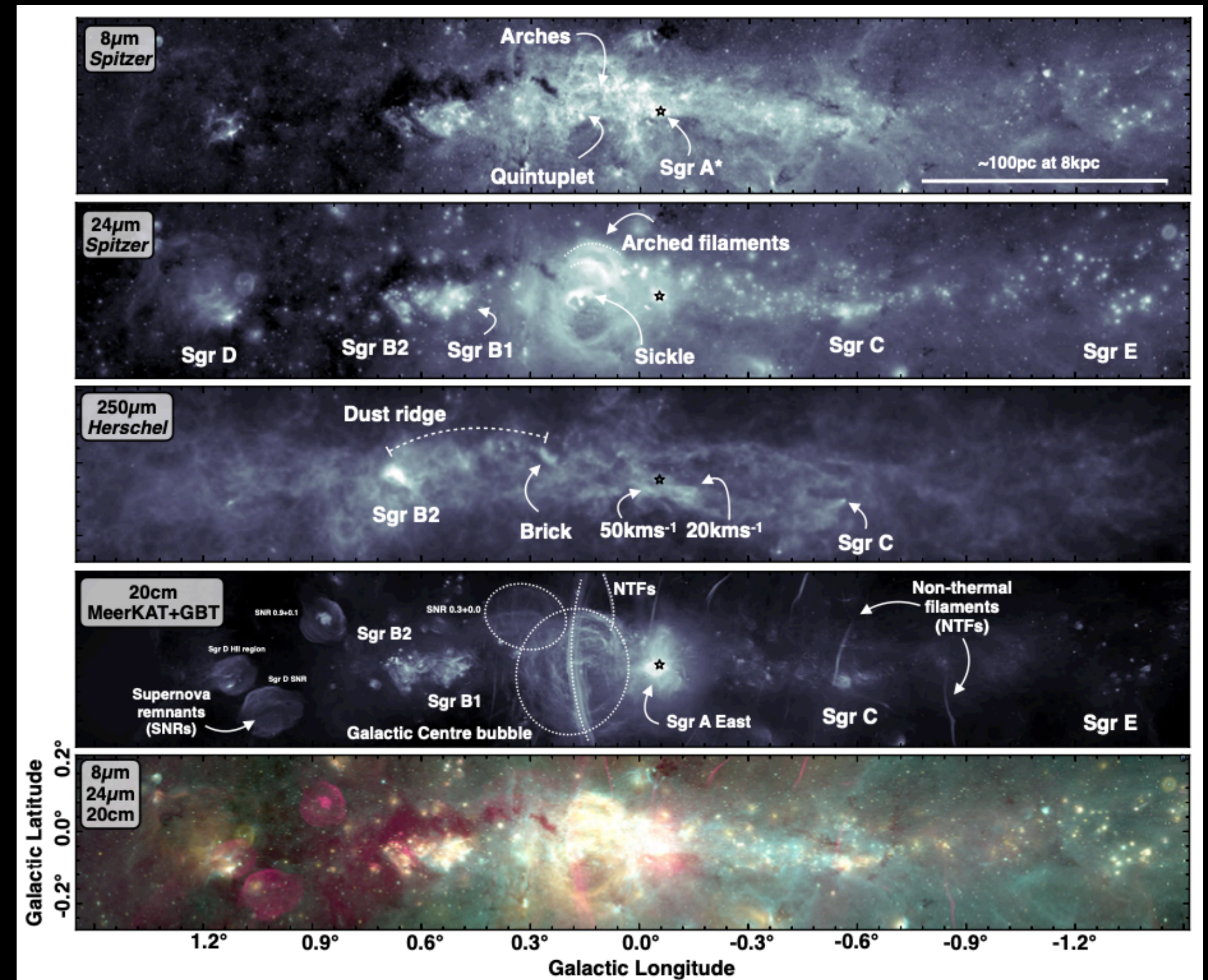# The MW Galactic Center is unique (woah really?)

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- Indeed: the CMZ does not follow common relations between a region's property (e.g., gas density, dense gas mass) and amount of star formation
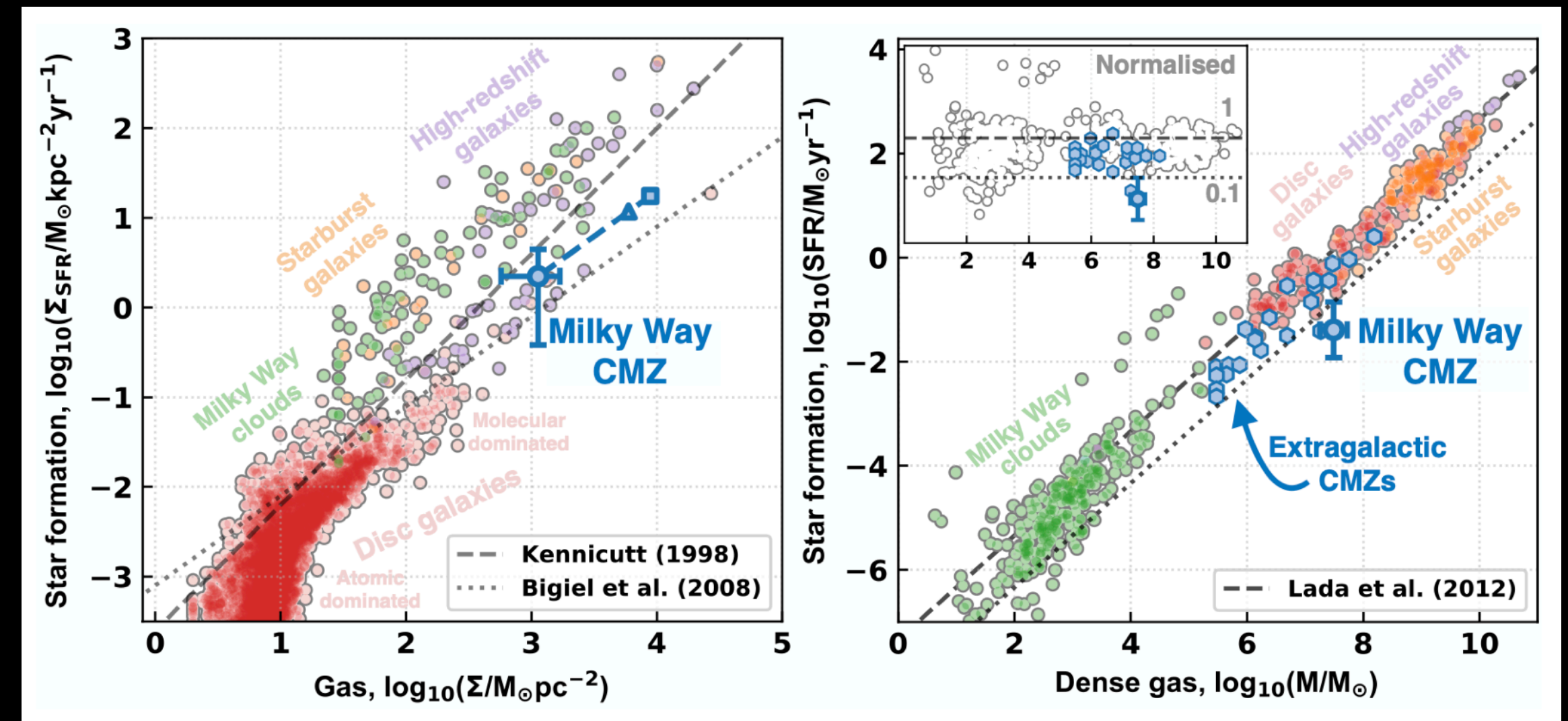
CMZ = Central Molecular Zone/molecular material within $R_{gal} \approx X00$ pc... plots from Henshaw+2023

How do we find where stars are forming?

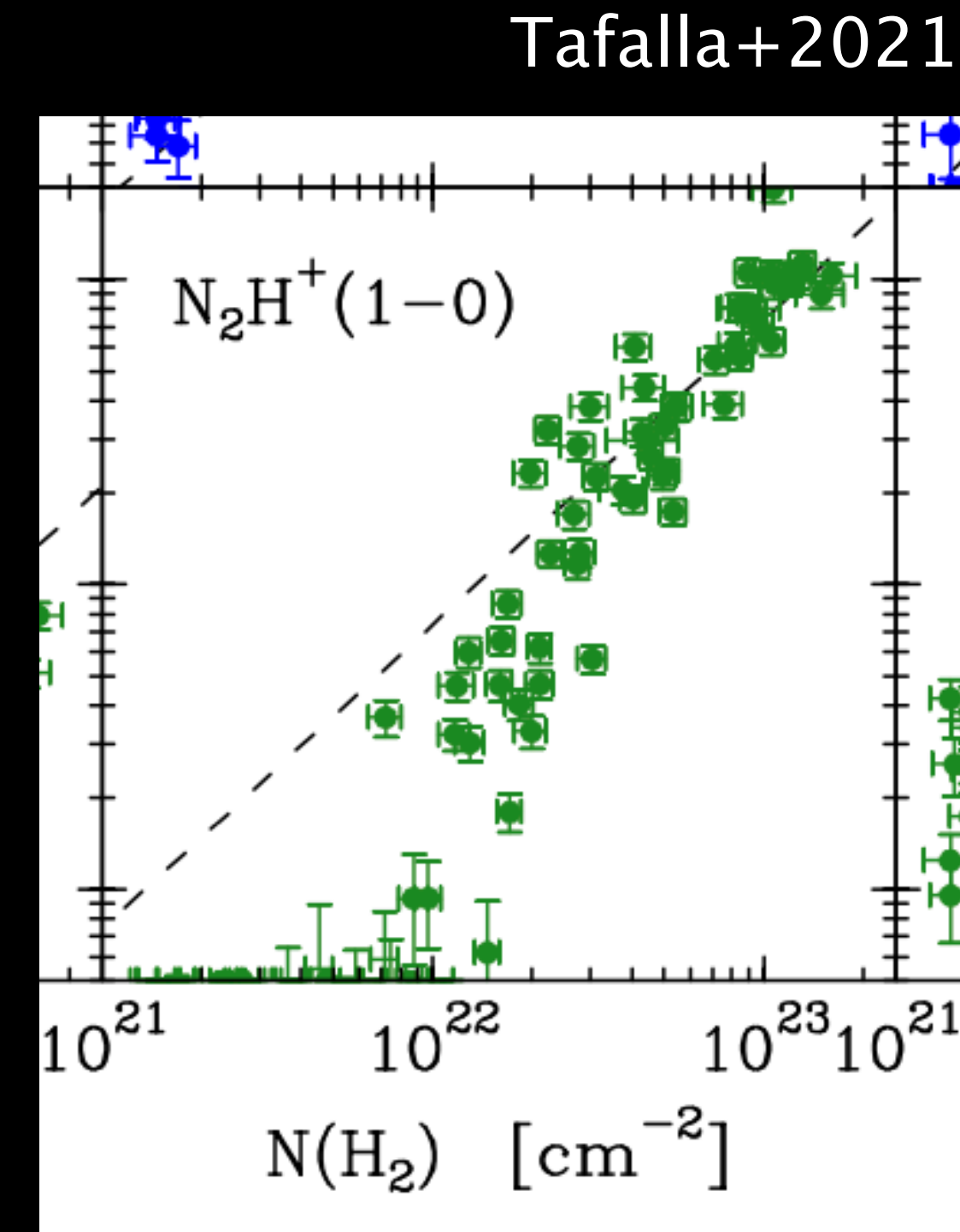*ACES = ALMA CMZ Exploration Survey, an ALMA Large Program*

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- We use molecules as tracers for dense gas (HCN, HNC, HCO^+, N_2H^+) and other SF processes (outflows, shocks)...

Tafalla+2021

$N_2H^+(1-0)$

$N(H_2)$ $[cm^{-2}]$

↑ only detected at high densities

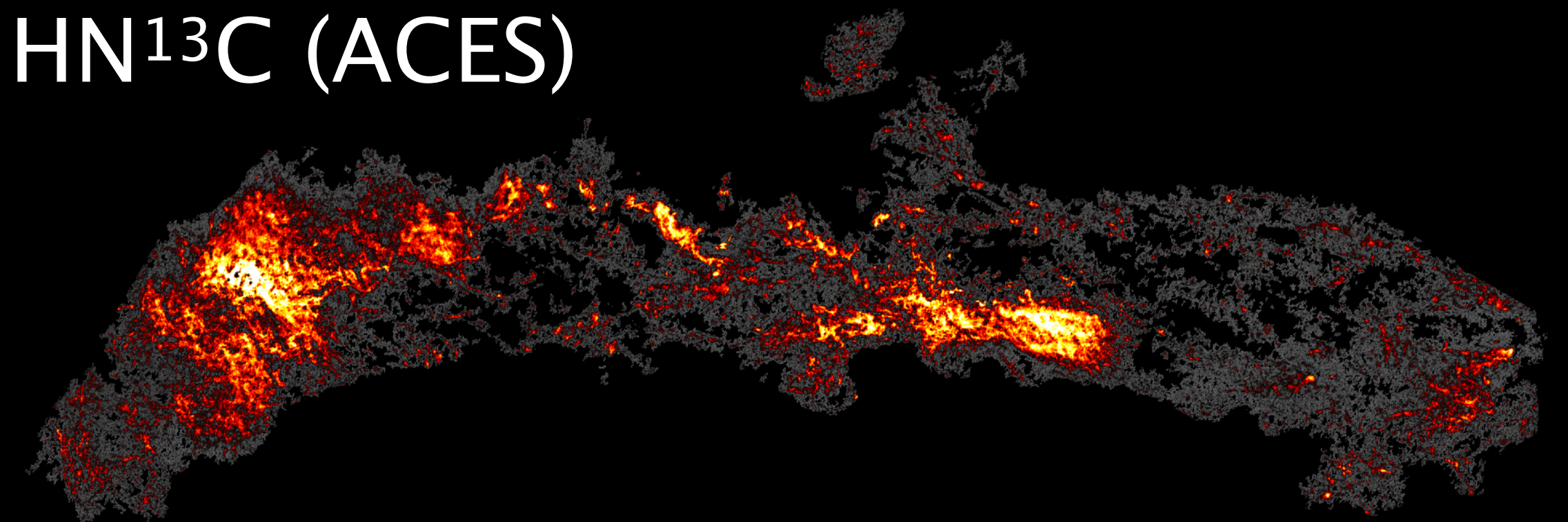*ACES = ALMA CMZ Exploration Survey, an ALMA Large Program*

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- … but the CMZ is too dense, shocked, and outflowing for these tracers to work

HCO$^+$ (ACES)
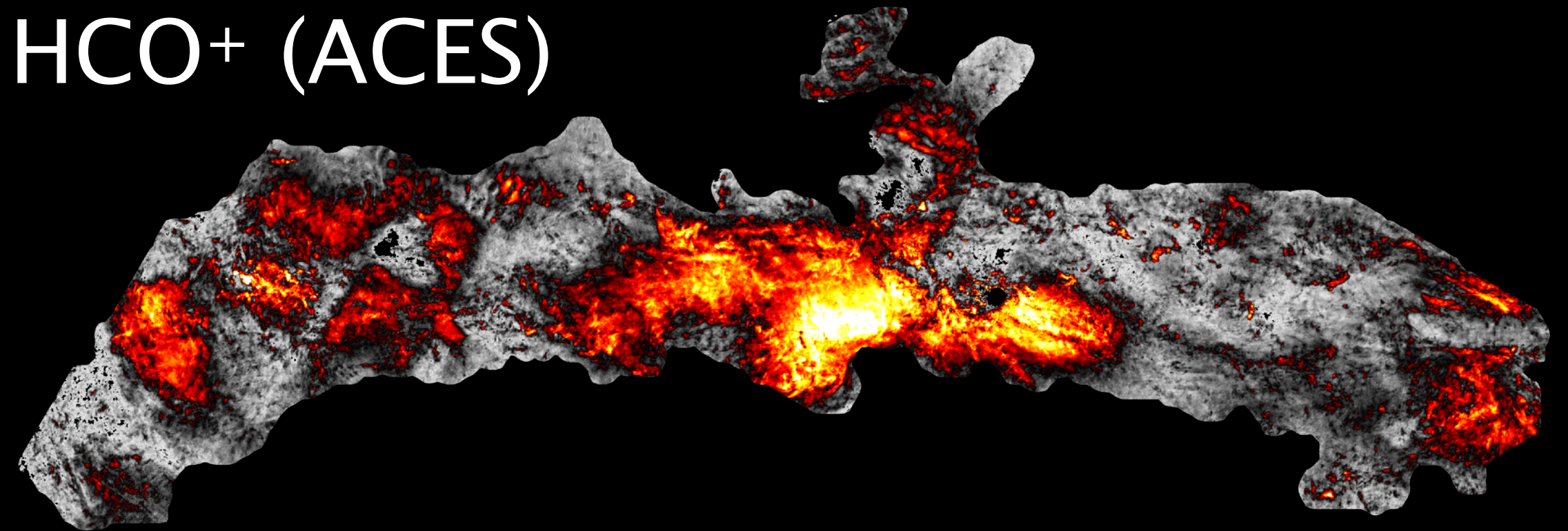
HN^{13}C (ACES)

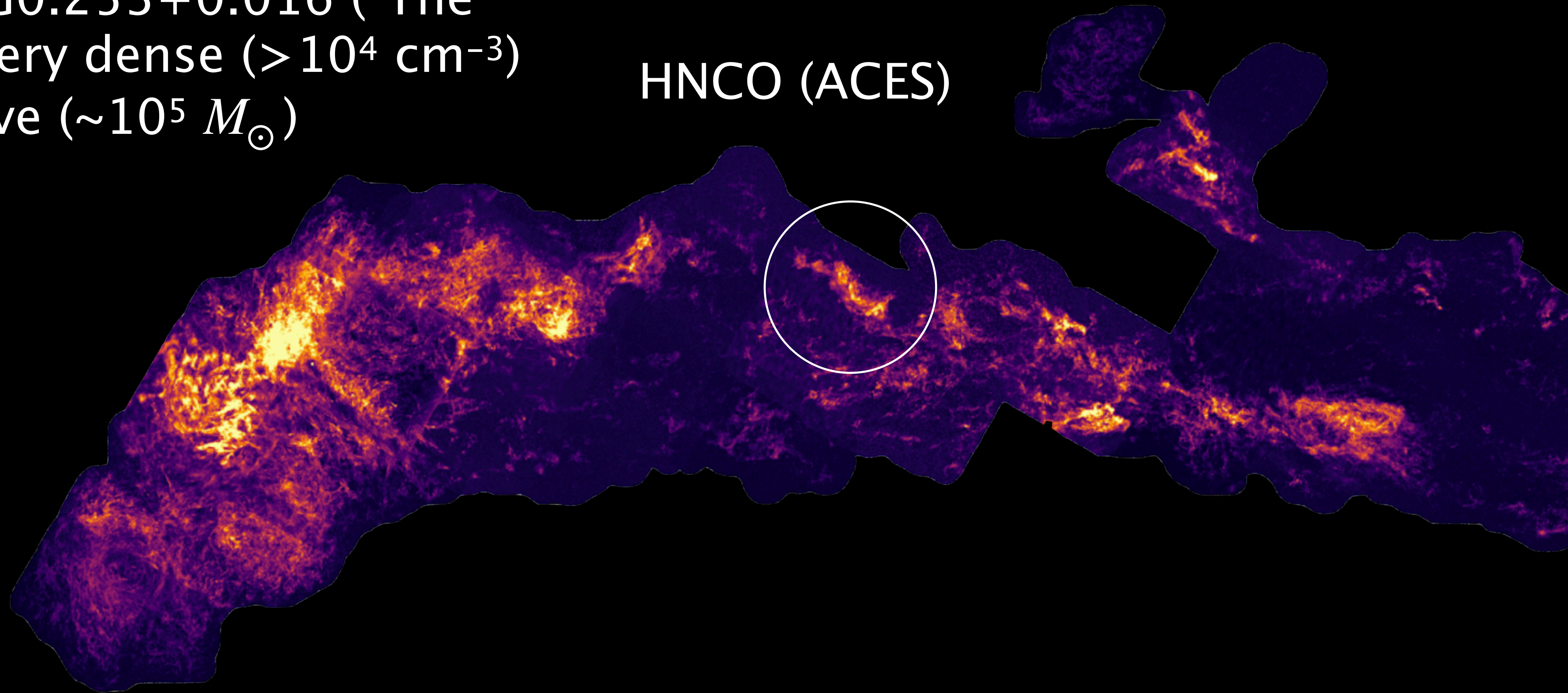*ACES = ALMA CMZ Exploration Survey, an ALMA Large Program*

Enter: the Brick Line Survey

ALMA = Atacama Large Millimeter/submillimeter Array, the biggest* radio telescope

Enter: the Brick Line Survey

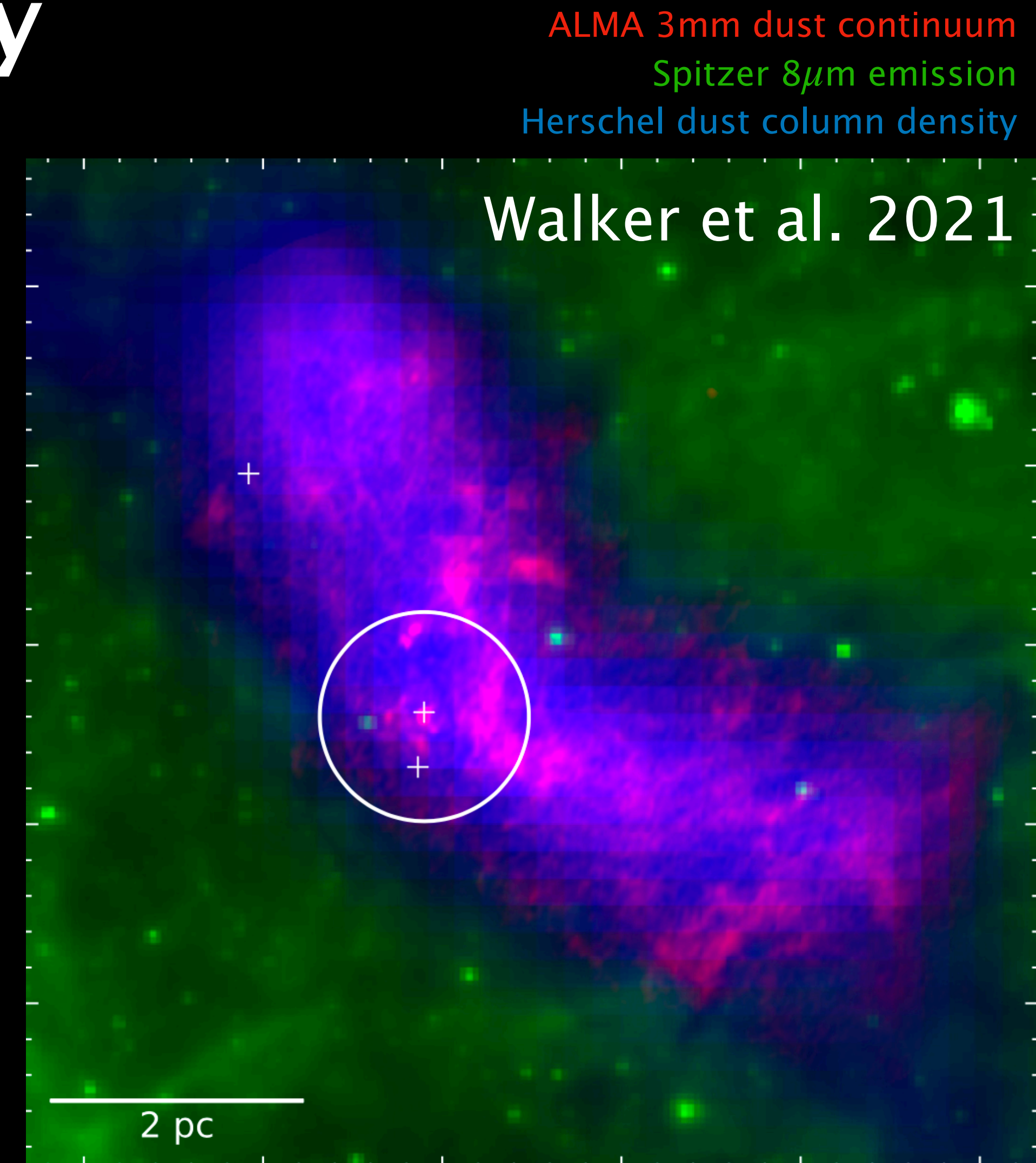- GC cloud G0.253+0.016 ("The Brick") is very dense ($>10^4$ cm^{-3}) and massive ($\sim 10^5\ M_\odot$)

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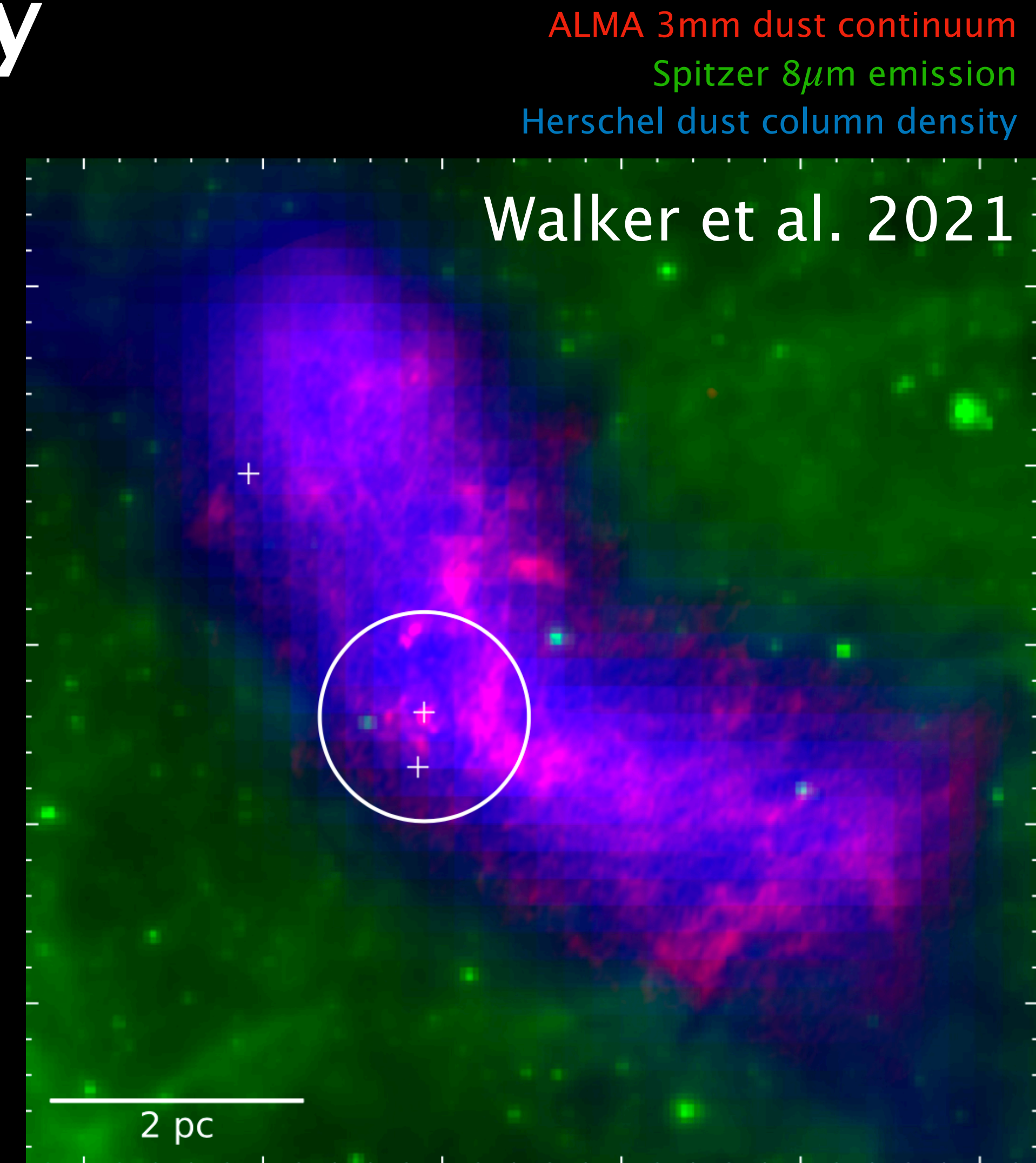
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ALMA 3mm dust continuum
Spitzer 8μm emission
Herschel dust column density

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Walker et al. 2021

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- It is representative of other CMZ clouds (dense and kinematically complex), but more interpretable than other CMZ sites of active, extreme SF (e.g., Sgr B2)

Walker et al. 2021

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The Brick Line Survey surveys lines in The Brick
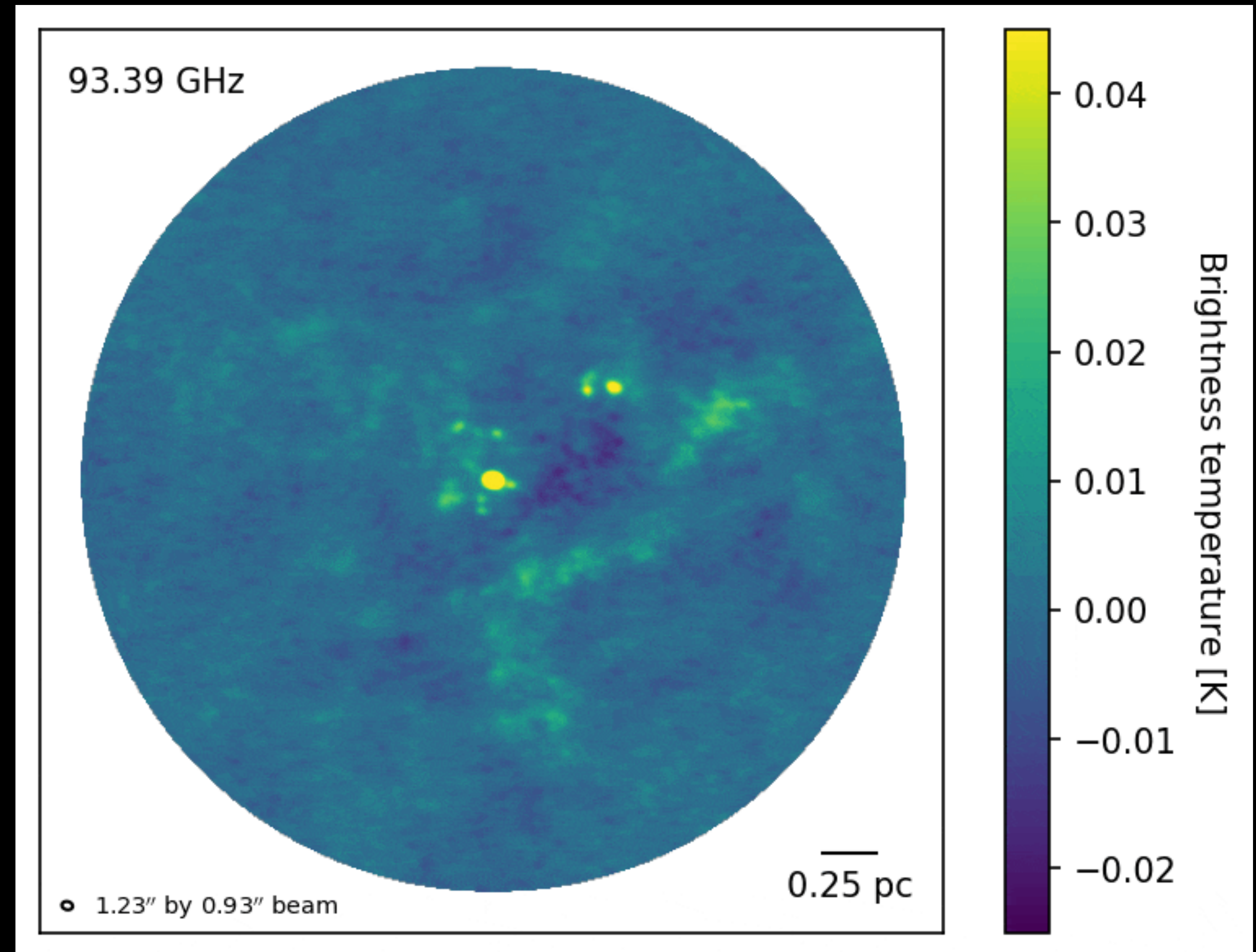
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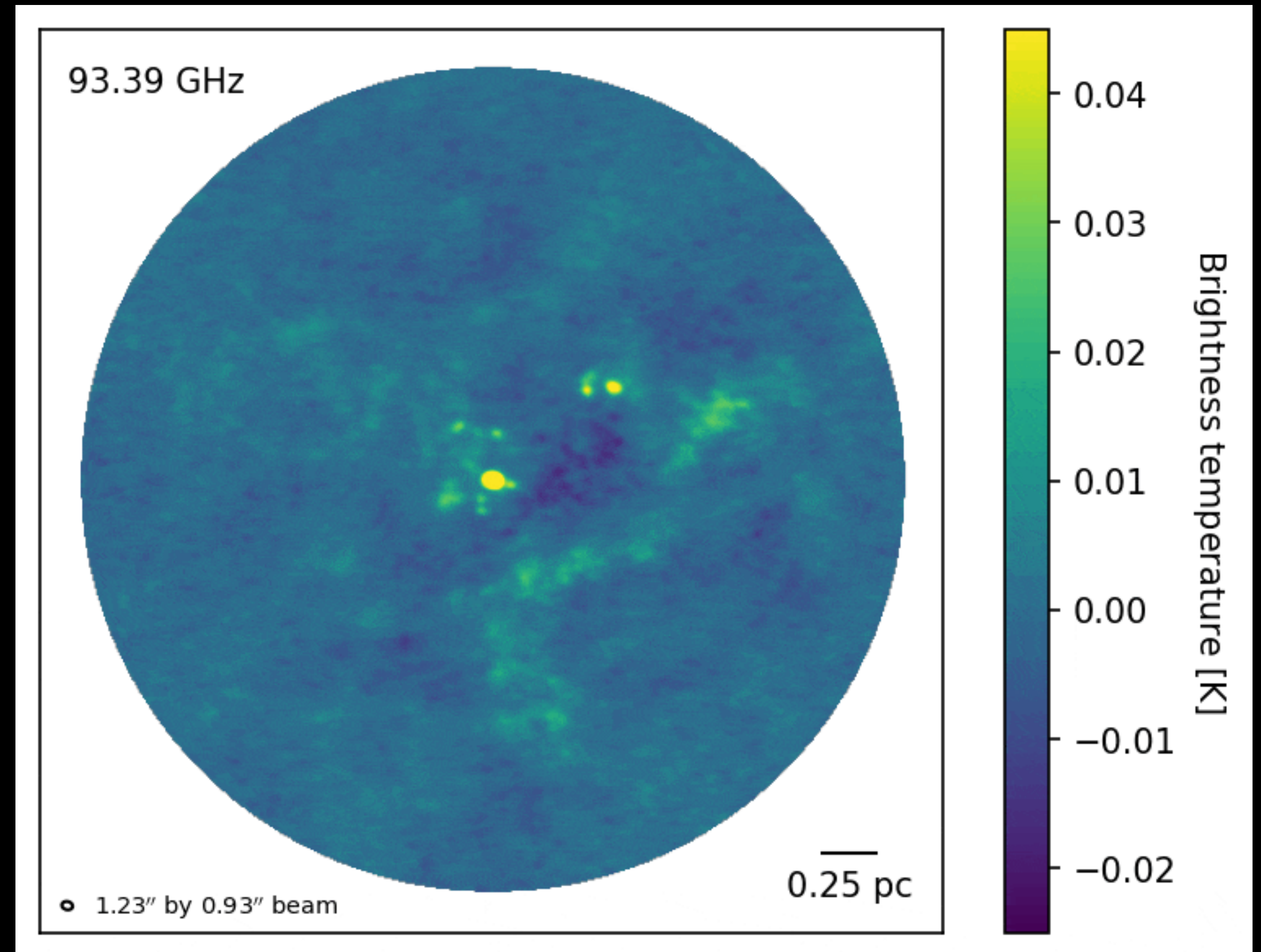
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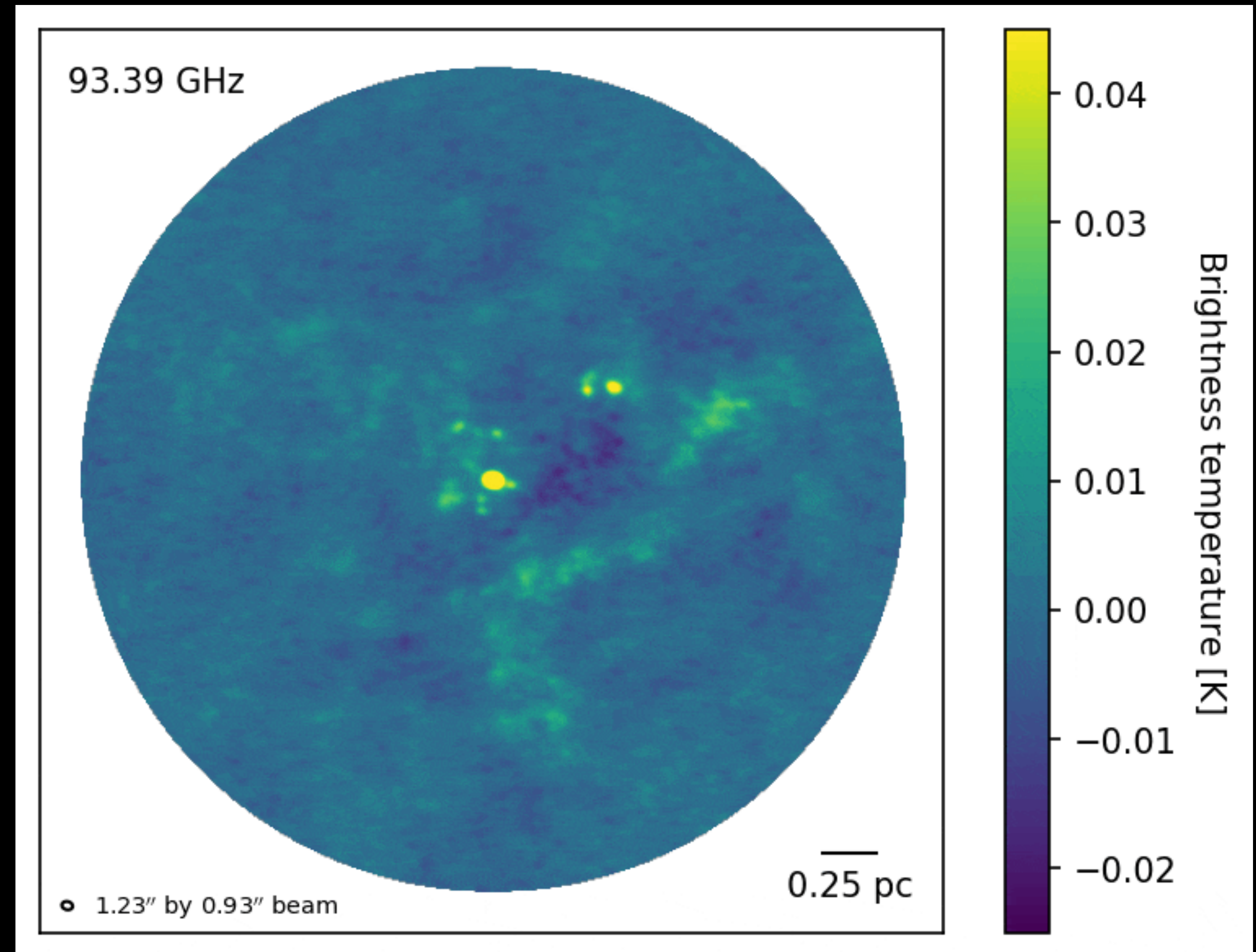# The Brick Line Survey surveys lines in The Brick

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- New tracers can be used to highlight areas of SF elsewhere in the CMZ and in extragalactic CMZs

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The Brick Line Survey surveys lines in The Brick

- <u>First step:</u> compare a prestellar core with more diffuse gas around it
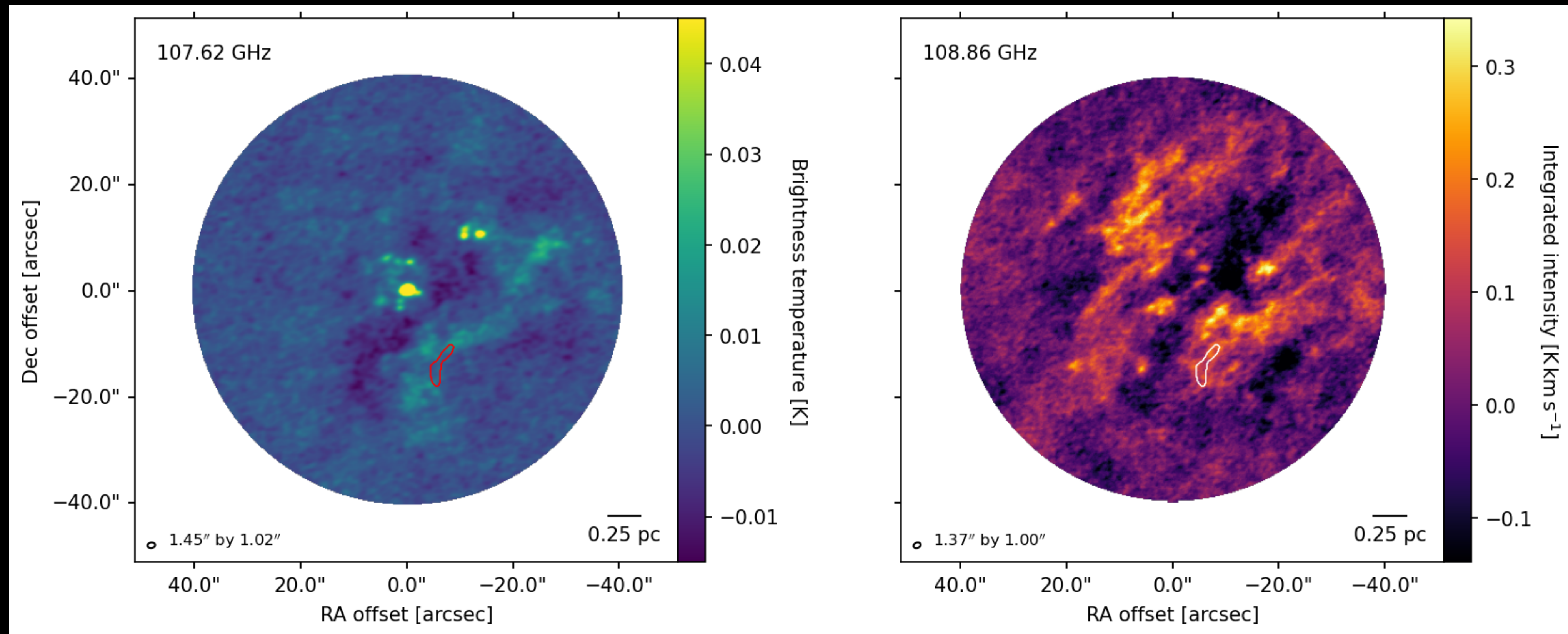
Left: part of Band 3 continuum, right: line emission at 108.86 GHz

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This was work performed from summer 2020 to fall 2024

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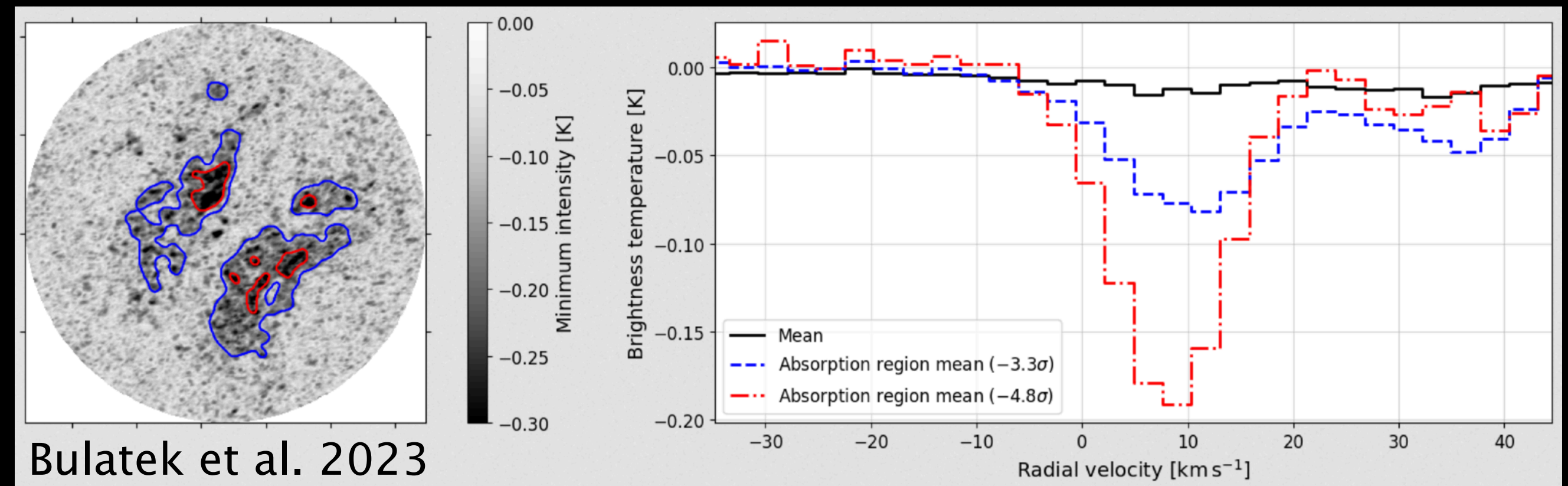*This was work performed from summer 2020 to fall 2024*

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Bulatek et al. 2023

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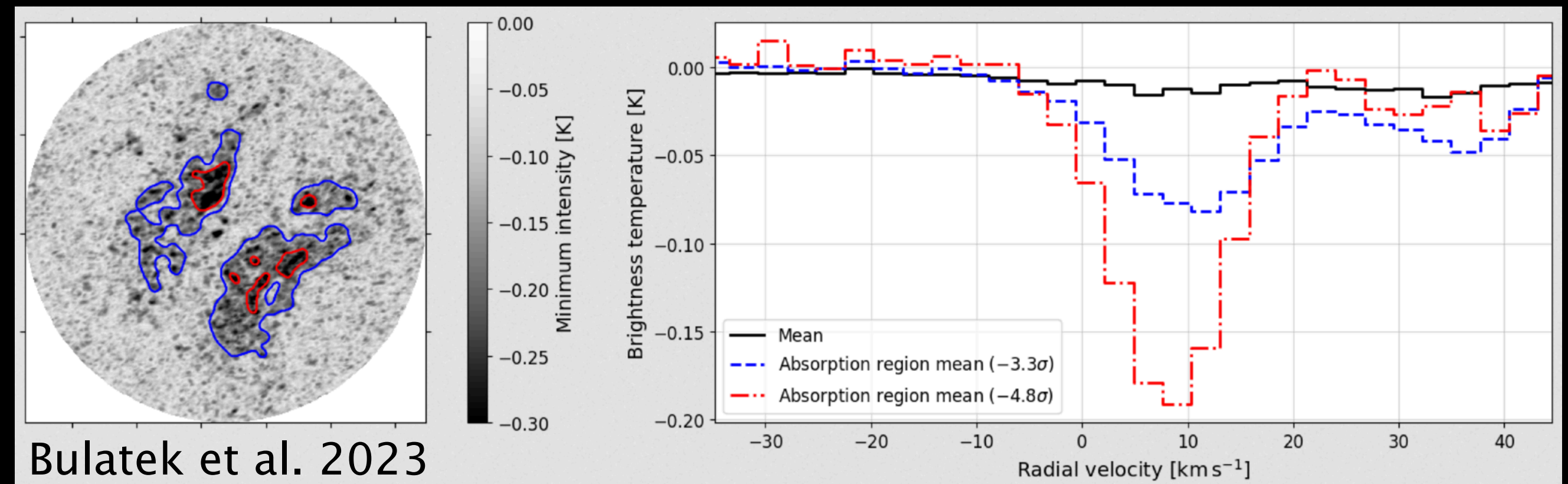
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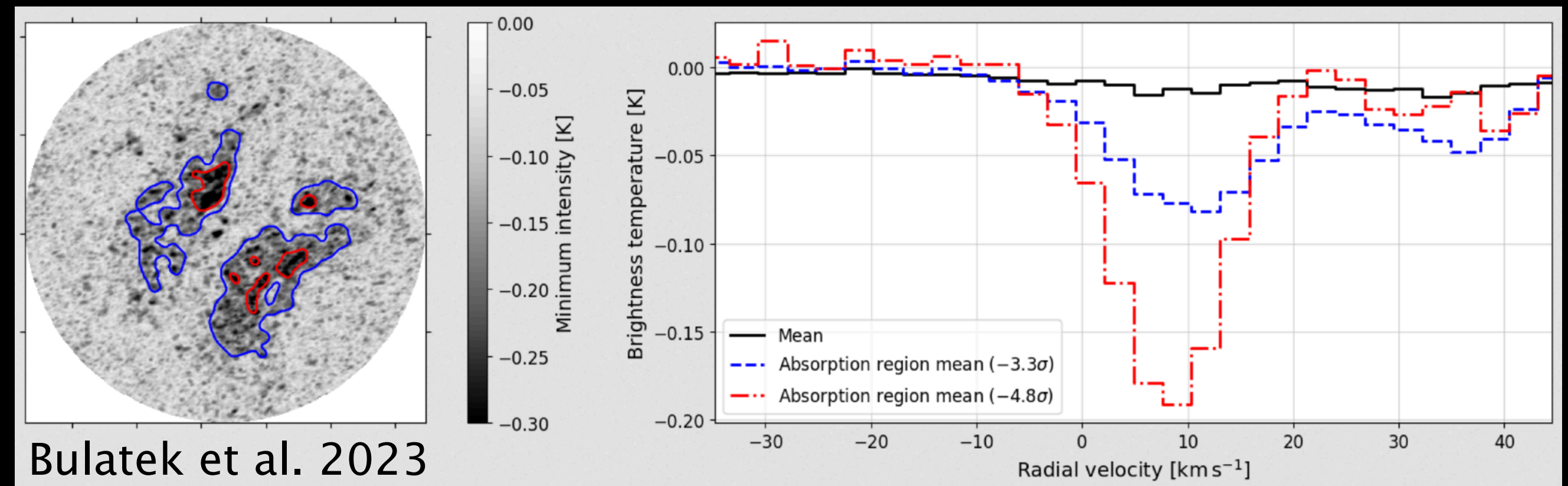# What have I done on the survey so far?

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  - Region of absorption ("the Frown") to contrast with molecules in core

Bulatek et al. 2023
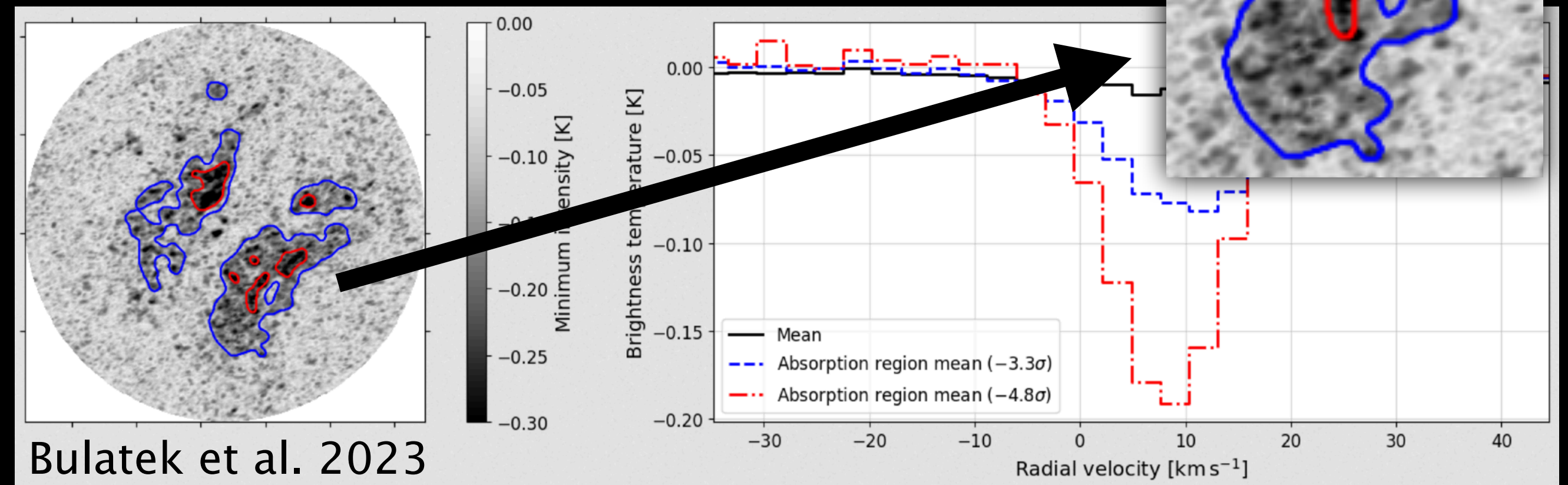
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What about since the last symposium?

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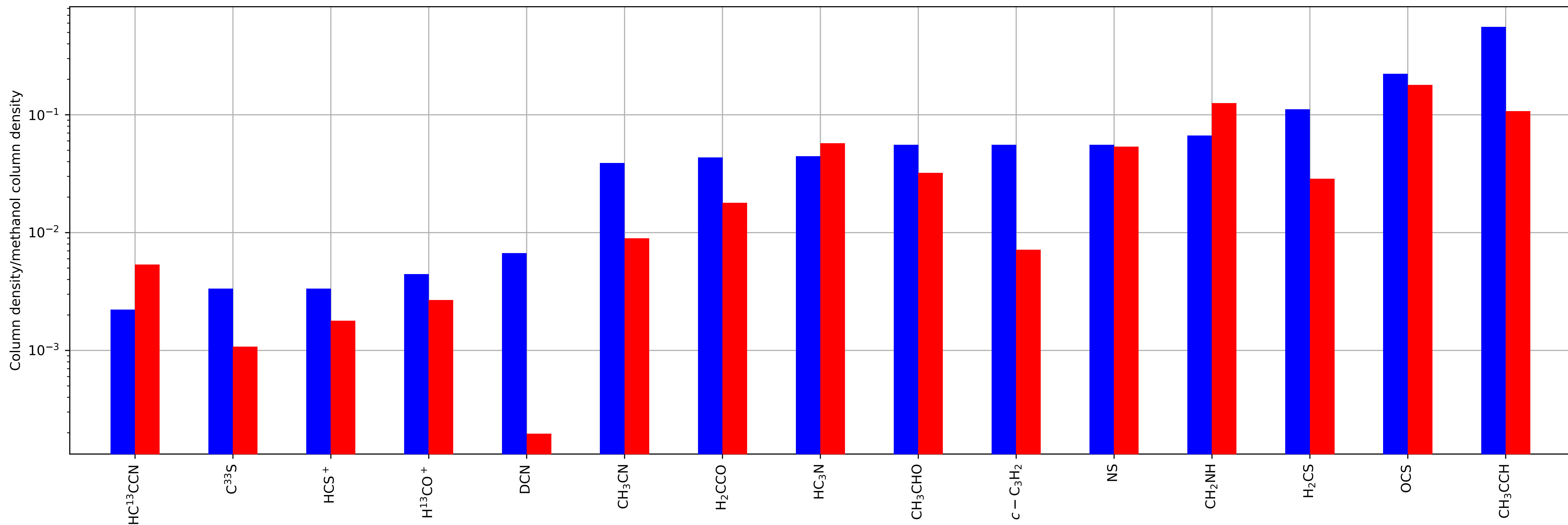- Comparing molecules between regions: trying to do science

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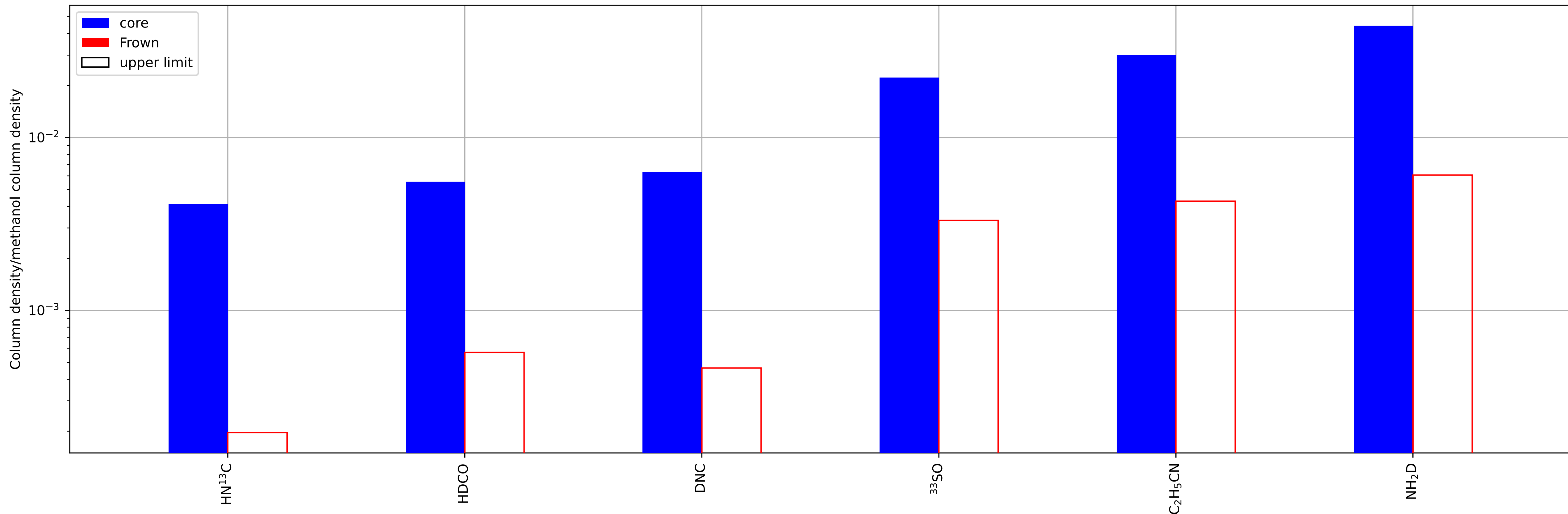
NEW: Updated "all molecules" plot (123 mols!)
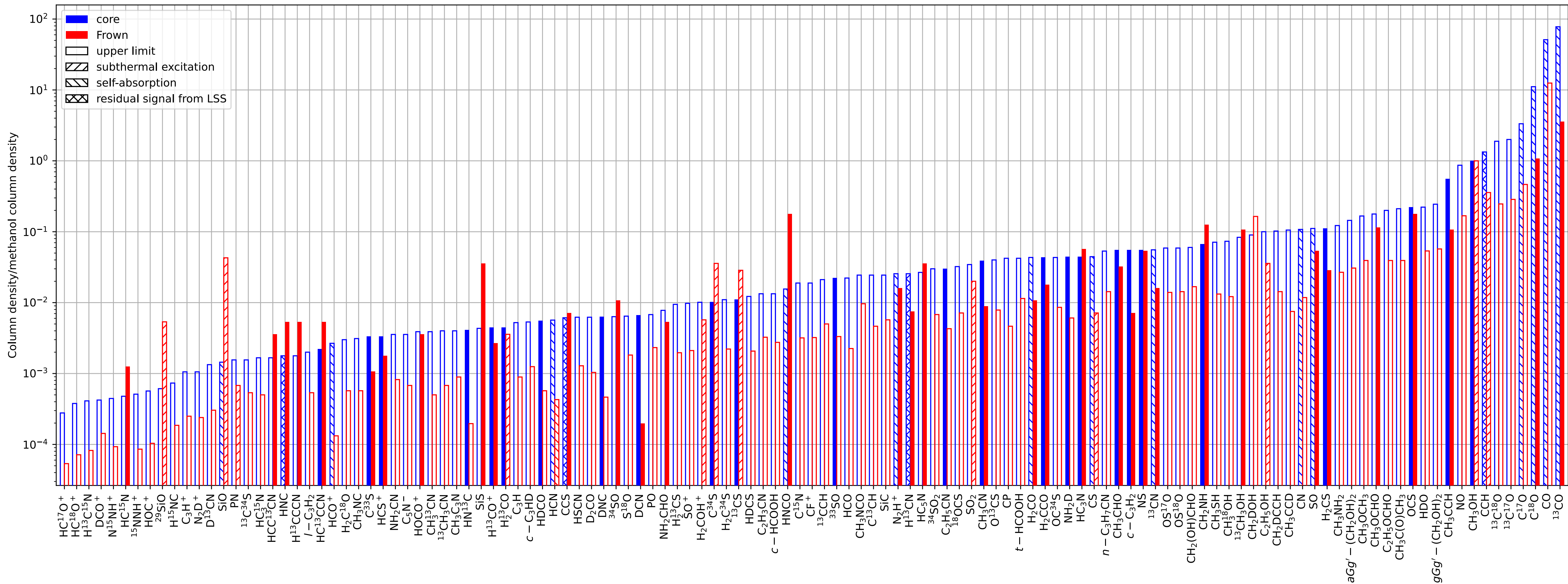
This isn't even all of them!!! Haha I still have to measure a lot of upper limits!!!

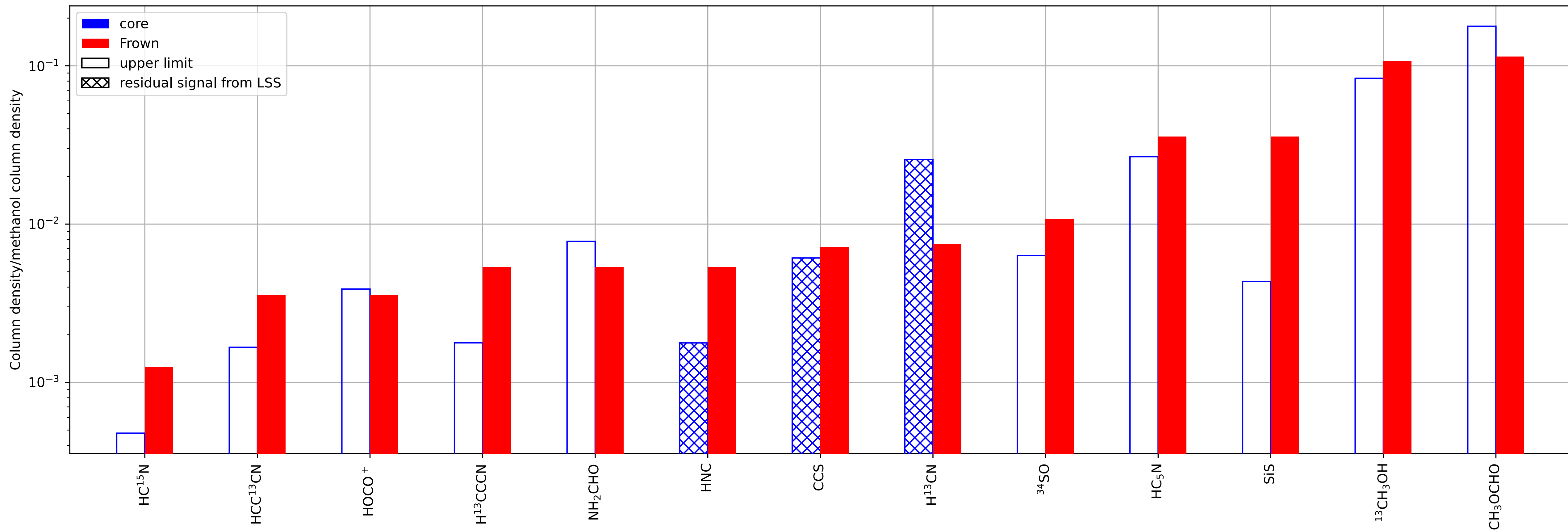**NEW: Molecules detected in the core AND Frown**

Some molecules are bright everywhere, even in The Brick (not super useful)

NEW: Molecules detected ONLY in the core

Only COM unique to the core is C_2H_5CN/ethyl cyanide

NEW: Molecules detected ONLY in the Frown

Unique COMs in the Frown: NH$_2$CHO/formamide, HC$_5$N, ^{13}CH$_3$OH/methanol, and CH$_3$OCHO/methyl formate

Thank you for coming
to my **TED** talk